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Testimony to the CGA Committee on Children
Testimony by Louis W. Burch
Citizens Campaign for the Environment

February 16, 2016
Hartford, CT

Senator Bartolomeo, Representative Urban, distinguished members of the CGA Committee on Children, thank you for the opportunity to submit testimony on this important issue.

My name is Louis Burch and I represent Citizens Campaign for the Environment (CCE). Supported by over 80,000 members in Connecticut and New York State, CCE works to empower communities and advocate solutions that protect public health and the natural environment. We would like to offer the following testimony in support of HB 5139:

Crumb rubber infill made from scrap automobile tires is a common fill material used in constructing children's playground surfaces and artificial turf athletic fields. Recent studies indicate that crumb rubber made from recycled tires contains a laundry list of known and possible human carcinogens, heavy metals, carbon black, volatile organic compounds (VOCs), and polyaromatic hydrocarbons (PAHs), which have been shown to volatilize into the air during normal playing conditions. Exposures to these materials have been linked to a wide range of potential health impacts, including eye and skin irritation, respiratory problems, and as many as three different forms of cancer.

<u>Notable highlights of recent studies on crumb rubber include:</u>

A recent chemical analysis conducted by the **Yale School of Forestry and Environmental Sciences** reviewed 14 different samples of crumb rubber, including 9 samples from 9 different bags of playground mulch. Researchers discovered that as many as half of the chemicals identified had received no previous health or safety testing done. Of the chemicals for which there was safety data available, 12 were known human carcinogens, and 20 were known eye, skin or lung irritants.[1]

The Empire State Consumer Project's 2015 Children's Products Safety Report found unsafe levels of heavy metals contained in samples of playground mulch, including arsenic, cadmium (both known human carcinogens) and zinc. The report also concluded that there is a higher incidence of knee injuries, sprains, and skin abrasions on artificial turf when compared to natural grass. Additionally, the report acknowledged that crumb rubber products can act as a heat sink on hot days, with ambient temperatures measuring up to

[1] http://www.ehhi.org/turf/findings0815.shtml

200 degrees Fahrenheit or more, creating an increased risk of heat stroke and dehydration in school children as well as professional athletes.[2]

This is consistent with a comprehensive study on the temperature of synthetic turf fields conducted at **Brigham Young University,** which concluded that the amount of light a field received had a greater impact on heating the fields than ambient air temperature. Surface temperatures on the fields were recorded as high as 200° F on a 98° F day. On average, the surface temperature of crumb rubber turf was found to be about 37° F hotter than asphalt and about 87° F hotter than natural grass, exacerbating public safety concerns over potential heat impacts[3].

A 2015 report from **The Concussion Legacy Foundation** concluded that the use of crumb rubber athletic fields may actually increase the risk of sports related concussions, and that the risk and severity of concussions increases as the fields deteriorate over time. Additionally, the report stated that children were disproportionally at risk of sustaining sports related concussions due to their size and developing bodies, and that the impacts of concussions on developing brains may be far more dangerous than they are for adults[4].

Children Face a Disproportionally High Risk

Children are disproportionately susceptible to the numerous health and safety hazards associated with crumb rubber, due to their rapidly growing bodies and developing biological systems. In fact, there is a growing number of doctors and public health professionals who have observed that youth athletes (particularly soccer goalies) who spend extended periods of time using those fields may in fact be at a higher risk of contracting certain cancers than the general public, including Lymphoma.

In light of the growing body of evidence pointing to significant health and safety hazards associated with crumb rubber, numerous municipalities have taken action to block the installation of crumb rubber products on public playgrounds and athletic fields. These include the City of Hartford, CT, which passed a local ordinance prohibiting the installation of artificial turf fields using recycled materials in January of 2016; the City of Edmonds, WA, which passed a temporary ban on crumb rubber in 2015; and the New York City Dept. of Parks and Recreation, which suspended the use of rubber infill on their parks and recreation facilities in 2008.

Most recently, the Obama administration announced last week that the U.S. Environmental Protection Agency (EPA), the Centers for Disease Control and Prevention Agency for Toxic Substances and Disease Registry (ATSDR), and the U.S. Consumer Products Safety Commission (CPSC) will be conducting a comprehensive and independent study to determine the full scope of potential health impacts associated with exposure to crumb rubber. This announcement comes as a significant shift in the federal government's previous assertion that the crumb rubber found in artificial turf and rubber playground mulch carries no significant adverse impacts to human health and is safe for use by children and youth athletes. CCE believes that this represents a major sea-change in public attitudes towards the use of crumb rubber, as growing scientific evidence points to significant health and safety risks. CCE urges Connecticut to follow this growing scientific evidence and demand a thorough investigation of toxic turf prior to allowing installations to continue.

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[2] http://www.synturf.org/images/EmpireStatechildrensproductssafetyreport2015_final_1_.pdf (pgs 18-22)
[3] https://www.westcoastturf.com/getdoc.cfm?id=38
[4]http://concussionfoundation.org/sites/default/files/Learning%20Center/The%20Role%20of%20Synthetic%20Turf%20in%20Concussion_0.pdf

In conclusion, CCE strongly supports prohibiting the use of crumb rubber on municipal playgrounds and public schools, and offers the following recommendations for consideration by the committee:

1) Legislation should be expanded to prohibit the use of crumb rubber on private and parochial school grounds, not just public schools;

2) The scope of this bill should be expanded include artificial turf athletic fields constructed with crumb rubber infill and not limited to the use of rubber mulch on children's playgrounds.

On behalf of our members in Connecticut, we appreciate the opportunity to provide testimony and look forward to working with you on this important issue.

AC005 (8/07)

EXAMINATION OF CRUMB RUBBER PRODUCED FROM RECYCLED TIRES

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Introduction

In June 2007 the Department of Analytical Chemistry at the Connecticut Agricultural Experiment Station (CAES) was contacted by Environment and Human Health Inc. (EHHI), a non-profit organization headquartered in the greater New Haven area, to ascertain if our laboratory would be willing to examine crumb rubber produced from used tires. The product in question has been gaining widespread use as an enhancement on athletic fields constructed from artificial turf; other applications, such as on play areas for children, are also common. Private citizens questioned EHHI as to the human health and environmental neutrality of the product. The data to answer the inquiries were not available (Anderson et al., 2006).

Figure 1 shows the crumb rubber infill on a synthetic turf field. The photo is of an actual field installed in Connecticut and was provided to us by EHHI.

Figure 1.

Given time and personnel limitations, the Department of Analytical Chemistry at the CAES agreed to conduct a very modest study of the material. Funding in the amount of $2000 was received from EHHI to offset the cost of items such as analytical and instrumental supplies and chemical standards. This fact sheet contains scientific information, described in detail below, derived from the preliminary study. The experiments were conducted by Dr. Mehmet Isleyen, with contributions from Dr. Saim Ozdemir, both visiting scientists from Sakarya University, Engineering Faculty, Environmental Engineering Department, Sakarya, Turkey, and with substantial input from William Berger of the Department of Analytical Chemistry. Dr. MaryJane Incorvia Mattina, the head of the Department of Analytical Chemistry, supervised the work.

Approach

It was deemed that answers to the following questions could be obtained within the time limitation imposed:

1. Are compounds volatilizing or out-gassing from the tire crumbs?
2. What is the identity of the volatilized compounds derived from the tire crumbs?
3. Can organic or elemental components be leached from the tire crumbs by water?

Experimental Details and Data

The crumb rubber examined is shown in Figure 2 and was provided to our laboratory by EHHI; the scale at the top of the photo is in centimeters (2.54cm/inch). Most of the crumbs were black, irregularly shaped particles <3mm in any dimension, although smaller particles may be seen in the photo. The material also contained lesser amounts of white crumbs similar in physical appearance to the black particles and presumed to be tire-derived rubber. The product was examined as received without any previous exposure to field conditions.

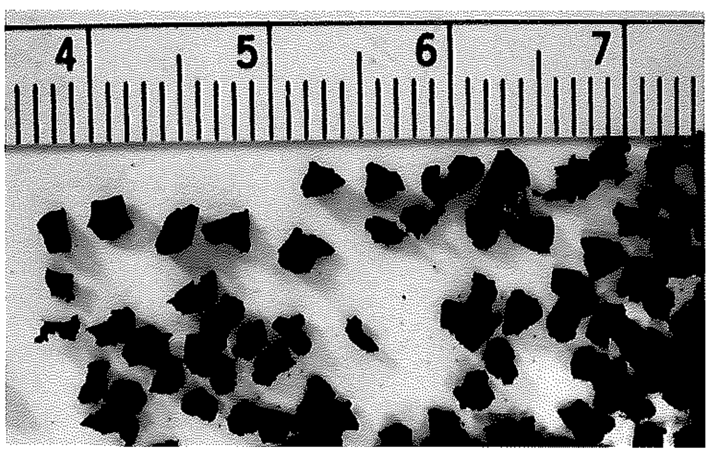


Figure 2.

Because of the substantial interest in this project, considerably more experimental details are provided in this fact sheet than is typical for such a publication. Experiments were conducted in the laboratory under conditions which approximated field conditions for parameters such as temperature and leaching solvent. The method relied on solid phase micro-extraction (SPME), a well-known and reliable analytical technique (Zeng and Noblet and references therein). The SPME fiber used was coated with 100μm thick polydimethylsiloxane (Supelco number 57342-U).

1. Are compounds volatilizing or out-gassing from the tire crumbs?

To obtain the data to answer this question 0.25g of tire crumbs were transferred to a glass, 2mL automated liquid sampling (ALS) vial. The vial was capped and the septum pierced with the SPME needle. The SPME fiber was exposed for 42 minutes to the headspace over the tire crumbs while the vial was warmed in a heating block to 60 °C. At the end of this period the

SPME fiber was removed from the vial and desorbed in the inlet of a gas chromatograph (GC, Hewlett Packard model 6890) at 260 °C. A 30m X 0.25mm DB-5MS+DG column (J&W Scientific) was interfaced to the mass spectrometer (MS, Hewlett Packard model 5973) detector. The GC oven was programmed as follows: initial temperature 40 °C for 5 min, ramped at 2 °C/min to50 °C, ramped at 5 °C/min to 160 °C, ramped at 10 °C/min to 300 °C and held for 10 min. Figure 3 shows a portion of the total ion chromatographic (TIC) trace typically obtained from several replicates of this experiment. Peaks were identified using high probability matching of the actual mass spectrum with that in the NIST library supplied with the software.

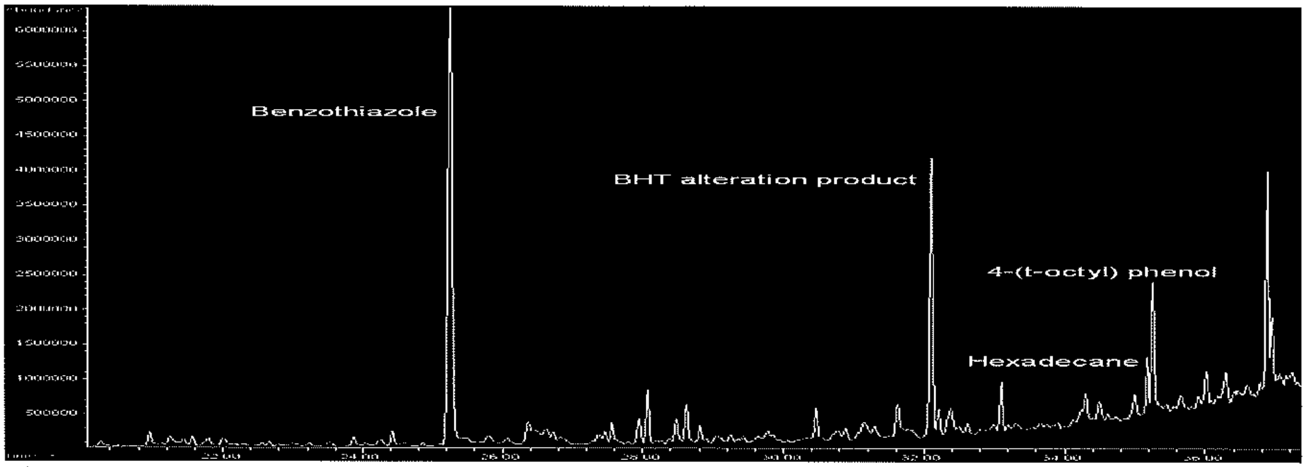
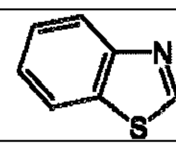
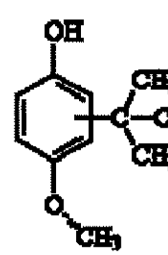
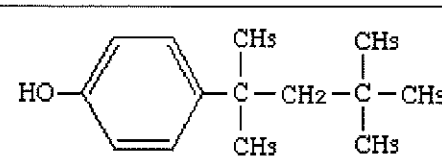


Figure 3.

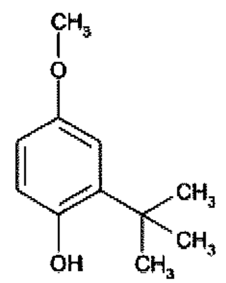
Using this approach of spectral matching several compounds were identified, some of which are summarized in Table 1:

Table 1. Organic Compounds Volatilizing from Tire Crumbs

NAME	CAS NUMBER	RETENTION TIME (min)	STRUCTURE
Benzothiazole	95-16-9	25.2	
Butylated hydroxyanisole	25013-16-5	32.7	
n-hexadecane	544-76-3	35.2	
4-(t-octyl) phenol	140-66-9	35.3	

2. What is the identity of the volatilized compounds derived from the tire crumbs?
In order to confirm positively the four compounds cited in Table 1 which have good match between the archived NIST spectrum and the spectrum recorded in this experiment, authentic standards were purchased from Sigma Aldrich. Solutions of the compounds were prepared in methanol and used to spike approximately 0.6 grams clean glass beads in 2 mL ALS vials. The same SPME procedure described above to collect volatile compounds from the tire crumbs was used to collect volatile compounds from the headspace over the spiked glass beads. The GC/MS analytical settings were also the same. The identity of the four compounds was confirmed with retention time (RT) match as well as mass spectral match. In order to assure that the compounds were not artifacts from laboratory background nor from any of the supplies used in the method, the following experiments were performed: (i) several consecutive desorptions of the SPME fiber in the GC inlet; (ii) SPME analysis of the headspace over clean glass beads in an ALS vial; (iii) SPME analysis of the headspace over glass beads in an ALS vial spiked only with methanol. None of the four compounds listed above was detected in any one of these three trials.

A comment must be made regarding butylated hydroxyanisole. Analysis of the purchased standard (Sigma catalogue number B1253-5G) resulted in detection of three peaks: RT=32.1, RT=32.5, RT=32.7 (major component). It should be noted that the structure matching this CAS number does not indicate a specific position of attachment of the t-butyl group relative to the hydroxyl group as shown above in Table 1. However, CAS 121-00-6 does correspond to 3-t-butyl-4-hydroxyanisole having the structure



Based on the mass spectral library match, we conclude that the compounds at RT 32.5 and 32.7 correspond to the two diastereomers of butylated hydroxyanisole. A search of the literature strongly suggests that the compound at RT 32.1, which has ions at m/z 236, 221, 205, 180, 165, 137, is 2,6-di-t-butyl-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one (Brumley et al., 1989) designated as an alteration product of 2,6-t-butyl-4-methylphenol (BHT). Peaks at the three RTs for analysis of the standard were found as well in the analysis of the tire crumbs.

Experiments were conducted to determine approximate gas phase concentrations of the organic compounds which volatilized or out-gassed from the crumb rubber. In this trial standards at different concentrations were spiked onto glass beads in ALS vials and the SPME procedure conducted. Calibration curves were constructed using the spiked standards from which gas phase concentrations of the compounds of interest in the vapor phase over the tire crumbs were determined. We make the assumption that due to the non-porous nature of the glass beads, the entire amount of the organic compound spiked onto the glass beads volatilized into the gas phase in the ALS vial. From the original amount spiked and the volume in the vial remaining after the volume of the beads is subtracted, we can calculate the amount of the compound in the headspace over the tire crumbs. These data in Table 2 should be considered a first approximation.

Table 2. Vapor phase concentrations of compounds out-gassed from crumb rubber

Compound	ng/mL air	ng/(mL air) normalized per gram of tire
Benzothiazole	225.87	866.72
Hexadecane	1.58	6.04
4-(tert-Octyl)-phenol	5.64	21.63
Butylated hyroxyanisole or BHT alteration product	13.89	53.32

3. Can organic and elemental components be leached from the tire crumbs by water?
To determine if materials of interest are extractable from the crumbs, portions of the crumb rubber were soaked over time in distilled, deionized water at ambient laboratory temperature in capped high density polyethylene (HDPE) jars. Approximately 17g of crumbs were soaked statically in 50mL water for seven weeks. After this period the leachate was filtered and 1.5mL transferred to ALS vials. The same SPME procedure was carried out as described above. A typical TIC trace for the headspace analysis is shown in Figure 4.

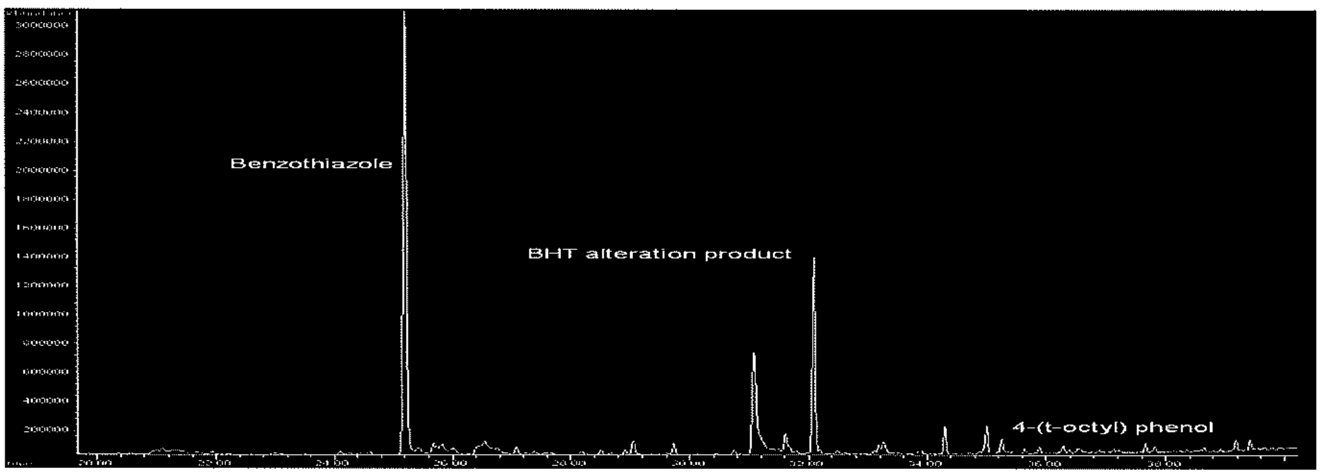


Figure 4.

Figure 4 should be compared with Figure 3. Although relative amounts of the compounds of interest differ under the two experimental conditions, the same compounds are noted in both Figures. If the SPME fiber is immersed directly into the leachate rather than exposed to the headspace over the leachate and then desorbed in the GC inlet, the same set of compounds as shown in Figure 4 was detected.

We now provide the experimental procedures used to determine if elements are leachable into aqueous solution from the crumbs. In this case 2.0 grams of crumbs were transferred into 40mL of water in 50mL centrifuge tubes. The tubes were sealed and agitated on a wrist action shaker at ambient temperature for 18 hours. Following this agitation the tubes were centrifuged for 10 minutes at 3000rpm and the leachate was analyzed using inductively coupled plasma mass spectrometry (ICP/MS, Agilent model 7500ce). In a second regime the leaching water was acidified to pH 4.2 prior to the 18 hour agitation. This procedure is based on conditions recommended in EPA SW-846 Method 1312. Pertinent data, averages of four replicates for each trial, are presented in Table 3.

Table 3. Elements leached into water from crumb rubber

Element	Amount in water (µg/kg tire)	Amount in acidified water (µg/kg tire)
Zinc	20957	55010
Selenium	246	260
Lead	1.85	3.26
Cadmium	0.07	0.26

Conclusions

The laboratory data presented here support the conclusion that under relatively mild conditions of temperature and leaching solvent, components of crumb rubber produced from tires (i) volatilize into the vapor phase and (ii) are leached into water in contact with the crumbs. We note with interest that when we placed the black crumbs in direct sunlight at an exterior air temperature of 88 °F, a thermometer inserted directly into the crumbs registered 55 °C (=131 °F). Selection of 60 °C, therefore, is not beyond a reasonable temperature range accessible under field conditions.

Based on these data further studies of crumb rubber produced from tires are warranted under both laboratory, but most especially field conditions. In particular examination of compounds volatilizing from the crumbs under exterior conditions and collected at varying heights and seasonal conditions at installed fields should be compared with background levels. It is also logical to determine airborne particulate matter deriving from the product under the same conditions.

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"Synthetic Surface Heat Studies"

C. Frank Williams and Gilbert E. Pulley
Brigham Young University

Synthetic turf surfaces have long been regarded as a lower maintenance alternative to natural turf. However, synthetic surfaces like natural turf have their shortcomings. In the spring of 2002 a Field Turf synthetic surface was installed on one half of Brigham Young University's Football Practice Field. The other half of the installation is a sand-based natural turf field. Shortly after the Field Turf was installed football camps were started. The coaches noticed the surface of the synthetic turf was very hot. One of the coaches got blisters on the bottom of his feet through his tennis shoes. An investigation was launched to determine the range of the temperatures, the effect water for cooling of the surfaces, and how the temperatures compared to other surfaces.

On June of 2002 preliminary temperatures were taken at five feet and six inches above the surface and at the surface with an infrared thermometer of the synthetic turf, natural turf, bare soil, asphalt and concrete. A soil thermometer was used to measure the temperature at two inches below the surface of the synthetic turf. Also, water was used to cool the surface of the natural and artificial turf. It was determined that the natural turf did not heat up very quickly after the irrigation so only the artificial turf was tracked at five and twenty minutes after wetting. The results of the preliminary study are shocking. The surface temperature of the synthetic turf was 37° F higher than asphalt and 86.5° F hotter than natural turf. Two inches below the synthetic turf surface was 28.5° F hotter than natural turf at the surface. Irrigation of the synthetic turf had a significant result cooling the surface from 174° F to 85° F but after five minutes the temperature rebounded to 120° F. The temperature rebuilt to 164° F after only twenty minutes. These preliminary findings led to a more comprehensive look at the factors involved in heating of the artificial turf.

Three aspects of light were measured along with relative humidity. The synthetic surface was treated as two areas, the soccer field and the football field and the natural turf was one area. Four randomly selected sampling spots were marked with a measuring tape from reference points on the fields so it could be accessed for subsequent data collection. Bare soil, concrete, and asphalt sampling areas were selected and marked in a similar manner. The results are shown in table form below:

Table 1.

Surface	**Average Surface Temperature between 7:00 AM and 7:00 PM**	
Soccer	117.38° F	high 157° F
Football	117.04° F	high 156° F
Natural Turf	78.19° F	high 88.5° F
Concrete	94.08° F	
Asphalt	109.62° F	
Bare Soil	98.23° F	

Table 2.

Two inch depth	**Average Soil Temperature between 7:00 AM and 7:00 PM**	
Soccer	95.33° F	high 116° F
Football	96.48° F	high 116.75° F
Natural Turf	80.42° F	high 90.75° F
Bare Soil	90.08° F	

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Synthetic Turf Fields
Fact Sheet

Background Information

• Used or "scrap" rubber tires present significant problems in solid waste management as their sheer numbers, flammability and indestructible nature make them persist in the environment. When disposed of in landfills, they take up massive amounts of space, leach toxic chemicals and collect water that creates a fertile breeding ground for disease-transmitting mosquitoes.

• There is a considerable effort to find uses for recycled rubber tires. Historically they have been used as fuel in the paper and cement industries, as road construction materials and in construction of drainage fields for septic systems, among other industrial applications. However, with the growing number of used tires and prohibitions for their disposal in landfills, new markets for this hazardous waste product are actively being sought.

• A relatively recent use of ground up used rubber tires, also known as "crumb rubber," is to cushion or infill synthetic turf fields or create playground surfaces. Up to 40,000 tires are recycled into crumb rubber pellets to use as infill material for a single field.

• The Resource Conservation and Recovery Act (RCRA) of 1976, our nation's primary law governing disposal of solid and hazardous waste, gives the EPA the authority to control hazardous waste from "cradle-to-grave," including used rubber tires. But it also states that the recycling of a hazardous waste product into a useable consumer product automatically exempts it from RCRA requirements, even if the end product it creates is more toxic than other similar products on the market. This loophole means that new products that have been manufactured from recycled hazardous waste, such as synthetic turf crumb rubber infill or recycled rubber playground surfaces, are not monitored.

Chemical Composition of Crumb Rubber

• The exact chemical composition of tires is largely determined by the intended use for the tire and the manufacturing location. Typical tire rubber contains 40-60% rubber polymer, 20-35% reinforcing agents, up to 28% aromatic extender oil, vulcanization additives, antioxidants, antiozonants, and processing aids (plasticizers and softeners).

Other Health Concerns

• **High temperatures on synthetic turf fields** - A comprehensive study on the temperature of synthetic turf fields was conducted by Brigham Young University. They found that the amount of light (electromagnetic radiation) had a greater impact on heating the fields than air temperature. The hottest field surface temperature recorded was 200° F on a 98° F day. Even on cooler days, field temperatures of 120° F to 174° F were recorded. In general, the surface temperature of the synthetic turf was 37° F hotter than asphalt and 86.5° F hotter than natural grass.

Serious heat-related health problems are associated with playing on synthetic turf fields, including dehydration, heat stroke and heat exhaustion. More frequent water breaks are a necessity and many players concur that the heat issue impacts their ability to perform their best. There are also many reports of burns and blisters on the soles of players' feet that occur when turf temperatures are dangerously high, even when they are wearing socks and shoes.

Water cannons or other irrigation systems can cool down a field for only about 20 minutes before the temperature rebounds to an unsafe level, requiring prodigious amounts of water and interrupting games or practices numerous times on hot days.

• **Body fluid contamination** – There is always potential for body fluid contamination on a playing field during normal sports activities, including blood, salivå, sweat and vomit. Natural grass fields have the advantage of soil microbes to help break down pathogens, but plastic surfaces on synthetic turf need to be disinfected after games to ensure safety. However, in practice, this is rarely, if ever, done and the use of chemical disinfectants (pesticides) adds an additional concern for the health and safety of players.

• **Injuries** – Although there is not enough research comparing injuries incurred on synthetic turf versus natural grass fields, there is compelling data indicating that joint injuries (especially ankles and knees) are more common on synthetic turf surfaces. The Hospital for Special Surgery in New York notes that despite progress by synthetic turf manufacturers in making their fields feel more "natural," players still suffer from debilitating turf toe (sprain of the main joint of the big toe), which is unique to artificial playing surfaces. Testing the surface for compaction (and resiliency) is recommended by manufacturers to avoid dangerously hard surfaces, but it is typically not part of field maintenance protocol. Almost 75% of NFL players feel that playing on synthetic turf increases soreness and fatigue.

• **Turf burns or abrasions and infections** – Skin abrasions (turf burns) are more common on plastic synthetic turf fields than natural grass fields and are typically larger in size, providing more opportunity for infection. Research on the causes of MRSA (Methicillin-resistant Staphylococcus aureus) outbreaks in sports teams is ongoing, but there appears to be an association with traumatized skin, as seen in turf burns, and this serious antibiotic-resistant staph infection. Medical experts have found that staphylococci and other bacteria can survive for more than 3 months on polyethylene plastic, the material used in the manufacture of synthetic turf carpets and grass blades.

• **Chemical flame retardants** – One of the more recent developments in the controversy over synthetic turf has been the vandalizing of fields by setting them on fire. Rubber tires (and tire crumbs) burn for long periods of time, releasing highly toxic smoke, which

YALE UNIVERSITY STUDY OF PLAYGROUND RUBBER MULCH AND SYNTHETIC TURF RUBBER TIRE INFILL

Findings of the chemical analysis conducted by Yale University of the crumb rubber tire infill used in synthetic turf and the rubber tire mulch used as surfacing material in toddler playgrounds.

The shredded rubber tire playground mulch samples tested were provided by the manufacturer and were purchased in new bags of rubber mulch for use in gardens and playgrounds. The rubber tire infill for synthetic turf fields was obtained as new infill material from installers of synthetic turf fields. There were 5 samples of infill from 5 different installers of fields and 9 different samples of rubber mulch taken from 9 different unopened bags of playground mulch.

RESULTS

There were 96 chemicals found in 14 samples analyzed. Half of those chemicals had no government testing on them - so we have no idea whether they are safe or harmful to health. Of those chemicals found that have had some government testing done on them these are the findings with their health effects.

<u>12 CARCINOGENS</u>

2-Mercaptobenzothiazole
Carcinogen, toxic to aquatic life

9,10-Dimethylanthracene
Carcinogen, respiratory irritant and can cause asthma

Bis(2-ethylhexyl) phthalate
Carcinogen, may cause damage to fetuses

Fluoranthene
Carcinogen, Fluoranthene is one of the U.S. EPA's 16 priority pollutant -- A PAH.

Heptadecane
Carcinogen

2-mercaptobenzothiazole
Carcinogen

Phenol, 4-(1,1,3,3-tetramethylbutyl)-
Carcinogen

Phenanthrene
Carcinogen - A PAH

3,5-di-tert-Butyl-4-hydroxybenzaldehyde
Irritant - causes irritation to eyes, skin and lungs.

Anthracene
Irritant - causes skin, eye and respiratory irritation. Breathing it can irritate the nose, throat and
lungs causing coughing and wheezing.

Benzenamine, 4-octyl-N-(4-octylphenyl)-
Irritant - causes eye and skin irritation

Benzenesulfonanilide
Considered hazardous, very little testing has been done on it.

Benzothiazole, 2-(methylthio)-
Irritant - causes Skin and eye irritation.

Dehydroabietic acid
Toxic to aquatic organisms

Docosane
Irritant - causes Skin irritation

Hexadecanoic acid, butyl ester
Irritant - causes eye, skin and lung irritant. Can cause reproductive effects.

Methyl stearate
Irritant - causes eye, skin and lung irritation.

Octadecane
Irritant - causes kin, eye and respiratory irritation

Octadecanoic acid also known as Stearic acid
Irritant - causes skin, eye and respiratory irritation

Oleic Acid
Irritant - causes skin and eye irritation

Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-ethyl-
Irritant - causes skin, eye and respiratory irritation

Tetradecanoic acid
Toxic to aquatic organisms. Skin and eye irritant.

Anthracene, 2-methyl-https://drive.google.com/file/d/0B10JrTWWsJzRX0YyYm9BQW5rcGM/view>https://drive.google.com/file/d/0B10JrTWWsJzRX0YyYm9BQW5rcGM/view

Empire State Consumer Project (ESCP) 2015 Children's Products Safety Report

Found arsenic, cadmium, and zinc at "higher than current acceptable limits."

ESCP claims it is the only consumer agency conducting chemical safety testing on artificial mulch made from ground up tires. Braiman says the product is similar to what you see in synthetic turf and is sold by the bag.
"They're selling it also for gardens. People put them in their food gardens and also use them for the play yards."

Braiman says their testing turned up levels of toxics that exceed state DEC levels for Brownfields, which are former hazardous waste sites.

CHEMICAL NAME			COMPARSION LIMITS			MEASURED CONCENTRATION IN PPM (MG/ KG)					
(Chemical group listed first)			NYS DEC			Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
			Limit								
Metals											
Arsenic			0.11			4.48	<0.455*	<0.467*	<0.472*	4.11	<0.490*
						40.727 x				37.363 x	
						limit				limit	
Cadmium			0.43			1.72	1.38	1.93	3.55	1.79	0.612
						4 x	3.2 x	4.488 x	8.255 x	4.162 x	1.424 x
						limit	limit	limit	limit	limit	limit
Zinc			1100			16700	16100	10200	7740	10800	15700
						15.182 x	14.636 x	9.272 x	7.036 x	9.818 x	14.272 x
						limit	limit	limit	limit	limit	limit
Semi-Volatile Organics											
(Base Neutrals): Analyte											
Chrysene			1			2.04	<1.460**	1.37	<0.286	1.05	0.487
						2.04 x		1.37 x		1.05 x	
						limit		limit		limit	

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WHITE PAPER

CONCUSSION LegacyFoundation

The Role of Synthetic Turf in Concussion

Introduction

As evidence of the serious consequences of concussion and repetitive brain trauma grows, the search intensifies for new methods of concussion prevention and mitigation. When it comes to the role of equipment and padding, helmets, headgear, and mouth guards dominate the conversation. One opportunity to reduce risk that is consistently overlooked is the role of the playing surface, and particularly the opportunity to reduce concussion risk by providing safer fields.

1 in 5 concussions is caused by a head to surface impact

In a study of a nationally representative high school population, 15.5% of concussions across multiple sports occurred as a result of contact with the playing surface.[1] An additional 6% of concussions were caused by secondary head to turf impact after a player to player impact.[1] The CDC estimates that between 1.6 and 3.8 million concussions occur in sports and recreation every year.[2] Therefore, contact with the playing surface may account for between 350,000 and 817,000 concussions per year in the United States.

The share of concussions caused by contact with the surface varies by sport and age. In a study of high school and college football players, contact with the playing surface was implicated in 10% of all concussions.[3] In soccer, Comstock[4] reported that 13.3% of concussions in boys high school soccer and 19.2% of concussions in girls high school soccer resulted from head to surface impact. In 5-19 year olds in Canada, Cusimano[5] found 17.5% of all soccer related concussions and 11.5% of all football related concussions resulted from head to surface impact.

Study	Sports	Ages	Concussions from Surface Impacts
Comstock et al, 2015	Soccer	High School	19.2% (Girls) 13.3% (Boys)
Guskiewicz et al, 2000	Football	College High School	10.0%
Cusimano et al, 2013	Soccer Football	5-19	17.5% 11.5%
Meehan et al, 2010	Football Soccer (Boys + Girls) Basketball (Boys + Girls) Wrestling Baseball Volleyball Softball	High School	15.5%

Table 1: Proportion of concussions by surface impacts across studies

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Turf field components and conditions can degrade over time and require regular maintenance

With regard to concussion, the protective characteristics of an artificial turf field have been found to degrade as the field sees more use.[9] From a structural perspective, the choice of components, including the foam under pad, can significantly alter impact attenuation.[19] Further, in fields using rubber infill, a popular design among newer turf fields, significant compaction can occur further decreasing impact attenuation in areas of the field that are more frequently used.[20] Decreased impact attenuation could increase the amount of force transferred to an athlete's head during a fall, potentially increasing their risk of sustaining a concussion.

While it is generally recommended turf be evaluated for firmness every year, few comply with the rule, and athletes play on turf that may be out of compliance.

Conclusion

Concussion prevention and mitigation is now a priority across all sports. There are no silver bullets when it comes to preventing concussion, and every opportunity to reduce risk must be explored. Currently, there is limited data on how much any one piece of athletic equipment may impact risk of concussion. Even with football helmets, an area of intense focus, recent field studies have not shown any specific brand or model of helmet to be more protective against concussion than another.[21]

Artificial surfaces should receive the same attention and scrutiny as football helmets. Despite one in seven high school sports concussions being caused by surface impacts, and one in four concussions in youth soccer and football, we have no national conversation on the technology underneath an athlete's feet. Helmet technology is an area of great attention and investment, and surfaces deserve the same attention.

About the Concussion Legacy Foundation:
The Concussion Legacy Foundation (formerly the Sports Legacy Institute) is a 501(c)(3) non-profit organization located in Boston, Mass. It was founded in 2007 by Dr. Robert Cantu and Christopher Nowinski to solve the concussion crisis by advancing the study, treatment, and prevention of the effects of brain trauma in athletes and other at-risk groups. For more information, please visit ConcussionFoundation.org. Chris Nowinski, Clifford Robbins, Peter Schade, and Dr. Robert Cantu contributed to this report.

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